CLAIMS

I/We claim:

1. A cleaning apparatus comprising:

a fluid dispensing tank which dispenses a cleaning fluid;

a heat exchanger coupled in downstream fluid flowing relation relative to the fluid dispensing tank;

a source of a combustible fluid fuel;

a source of air; and

a catalytic heater positioned in heat transferring relation relative to the heat exchanger, and which further is coupled in fluid flowing relation relative to the combustible fluid fuel, and wherein the catalytic heater catalytically combusts a substantially nonflammable mixture of the combustible fluid fuel and air to produce heat energy which heats the fluid dispensed from the fluid dispensing tank.

2. A cleaning apparatus as claimed in claim 1, and wherein the mixture of the combustible fluid fuel and air has a stoichiometry which is defined, in part, by a lower explosive limit, and wherein the nonflammable mixture of the combustible fluid fuel and air has a stoichiometry of less than about one-half of the lower explosive limit during normal operation.

3. A cleaning apparatus as claimed in claim 1, and further comprising:

a pump coupled in fluid flowing relation relative to the fluid dispensing tank and which is operable to remove the cleaning fluid and supply it to the heat exchanger; and

a filter for removing particulate matter from the cleansing fluid and which is disposed in downstream fluid flowing relation relative to the fluid dispensing tank, and in upstream fluid flowing relation relative to the pump.

4. A cleaning apparatus as claimed in claim 1, and further comprising:

a remotely controllable fluid flow control device disposed in selective fluid metering relation relative to the source of combustible fluid fuel; and

a controller controllably coupled with the remotely controllable fluid flow control device and which causes the selective delivery of the combustible fluid fuel to the catalytic heater.

5. A cleaning apparatus as claimed in claim 1, and further comprising:

a blower assembly, which when energized, supplies the source of air which is mixed with a stream of combustible fluid fuel supplied by the source of combustible fluid fuel;

an air flow sensor positioned in a location to detect the rate of air flow supplied by the blower assembly and which produces a signal representative of the rate of air flow;

a remotely controllable fluid flow control device disposed in selective fluid metering relation relative to the source of the combustible fluid fuel; and

a controller electrically coupled with the air flow sensor and which detects the air stream which is produced by the blower and which is mixed with the source of combustible fluid fuel, and which further regulates the remotely controllable fluid flow control device to insure that the mixture of air and the combustible fluid fuel is substantially nonflammable during normal operation.

6. A cleaning apparatus as claimed in claim 1, and further comprising:

a heating enclosure which defines a passageway;

a blower assembly mounted on the heating enclosure, and which, when energized, produces an air stream from the source of air, and which is delivered to the heating enclosure, and wherein the source of the combustible fluid fuel is delivered to the passageway of the heating enclosure and mixed with the air stream;

an air stream sensor mounted in sensing relation relative to the passageway of the heating enclosure and which is operable to detect the volume of the air stream which is mixed with the combustible fluid fuel and which produces a signal representative of the air volume; and

a controller electrically coupled with the air stream sensor and which is further disposed in controlling relation relative to the supply of the combustible fluid fuel to controllably deliver the combustible fluid fuel to the passageway, and wherein the catalytic heater is mounted on the heating enclosure.

7. A cleaning apparatus as claimed in claim 1, and further comprising:

a temperature sensor located in a position to detect the temperature of the cleaning fluid which is leaving the heat exchanger;

a fuel sensor positioned adjacent to the catalytic heater, and which is operable to detect any noncombusted fuel which passes through the catalytic heater; and

a controller coupled in sensing relation relative to both the temperature, and fuel sensors.

8. A cleaning apparatus as claimed in claim 1, and further comprising:

a fluid dispenser coupled in downstream fluid flowing relation relative to the heat exchanger, and which is operable to dispense the heated cleaning fluid on an object of interest;

a conduit coupling the fluid dispenser with the fluid dispensing tank; and

a valve for selectively diverting the heated cleaning fluid to the fluid dispensing tank, or the fluid dispenser.

9. A cleaning apparatus as claimed in claim 8, and further comprising:

a moveable carriage, and wherein the fluid dispensing tank, heat exchanger, source of combustible fluid fuel, and the catalytic heater are mounted on the moveable carriage, and wherein the fluid dispenser is borne by the moveable carriage.

10. A cleaning apparatus as claimed in claim 8, and further comprising:

a moveable carriage, and wherein the fluid dispensing tank, heat exchanger, source of combustible fluid fuel, and catalytic heater are mounted on the moveable carriage, and wherein the fluid dispenser is coupled to the carriage by a fluid conduit.

11. A cleaning apparatus as claimed in claim 1, and further comprising:

a fluid recovery tank which is operable to receive cleaning fluid once it has been previously dispensed by the cleaning apparatus.

12. A cleaning apparatus, comprising:

a fluid dispensing tank which dispenses a cleaning fluid which is to be applied to an object of interest;

a fluid dispenser coupled in fluid receiving relation relative to the fluid dispensing tank;

a heat exchanger disposed downstream of the fluid dispensing tank and upstream of the fluid dispenser, and which is operable to impart heat energy to the fluid moving from the fluid dispensing tank to the fluid dispenser;

a catalytic heater disposed in heat transferring relation relative to the heat exchanger; and

a fuel supply coupled in fluid flowing relation relative to the catalytic heater, and wherein the combustion of the fuel supply with a source of air by the catalytic heater produces substantially no toxic emissions, and generates heat energy which heats the cleaning fluid dispensed by the fluid dispensing tank.

13. A cleaning apparatus as claimed in claim 12, and further comprising:

a waste cleaning fluid recovery tank; and

a waste cleaning fluid recovery tool which is coupled in fluid flowing relation relative to the waste cleaning fluid recovery tank, and wherein the fluid dispenser is mounted near the waste cleaning fluid recovery tool.

14. A cleaning apparatus as claimed in claim 12, and further comprising:

a blower assembly, which when energized, produces an air stream which is supplied to and mixed with a fuel stream supplied from the fuel supply to provide a nonflammable mixture of the fuel and air to the catalytic heater.

15. A cleaning apparatus as claimed in claim 14, and wherein the fuel supply is hydrogen and wherein the nonflammable mixture of hydrogen and air contains less than about 2% hydrogen by volume during normal operation.

16. A cleaning apparatus as claimed in claim 12, and further comprising:

a heating enclosure which defines a passageway;

a blower assembly mounted adjacent to the enclosure and which, when energized, produces an air stream which is directed along the passageway, and wherein the catalytic heater is positioned in fluid flowing relation relative to the heating enclosure;

an air flow sensor positioned in the passageway and which is operable to detect the volume of the air stream;

a remotely controllable fluid flow control device which is disposed in selective fluid metering relation relative to the fuel supply, and wherein the remotely controllable fluid flow control device selectively delivers a fuel stream from the supply of fuel to the passageway, and wherein the remotely controllable fluid flow control device further delivers the fuel stream in an amount which when mixed with the air stream results in a substantially nonflammable mixture; and

a controller coupled in controlling relation relative to the remotely controllable fluid flow control device, and the blower assembly, and which further is disposed in sensing relation relative to the air flow sensor, the controller causing the delivery of the fuel stream following the creation and detection of the air stream to create the substantially nonflammable mixture which is delivered to the catalytic heater for combustion.

17. A cleaning apparatus as claimed in claim 16, and wherein the catalytic heater comprises a substantially monolithic catalyst block.

18. A cleaning apparatus as claimed in claim 17, and wherein the heating enclosure further defines a mixing plenum which substantially mixes the air stream with the fuel stream supplied to the passageway.

19. A cleaning apparatus, comprising:

a housing defining an internal cavity;

a fluid dispensing tank borne by the housing and which receives a source of fluid to be dispensed to an object of interest;

a pump enclosed within the housing and which is coupled in fluid removing relation relative to the fluid dispensing tank;

a heat exchanger coupled in fluid receiving relation relative to the pump;

a fluid dispenser coupled in fluid flowing relation relative to the heat exchanger and which dispenses the fluid from the fluid dispensing tank on an object of interest, and

which is further coupled in selective fluid flowing relation relative to the fluid dispensing tank;

a source of a fuel borne by the housing; and

a catalytic heater assembly coupled in fluid flowing relation relative to the source of fuel and which further is disposed in heat transmitting relation relative to the heat exchanger, and wherein the catalytic heater assembly, when supplied with the source of fuel, heats the fluid dispensed by fluid dispensing tank so that the heated fluid may be delivered to the object of interest.

20. A cleaning apparatus as claimed in claim 19, and further comprising;

a heating enclosure defining a passageway;

a blower assembly located adjacent to the heating enclosure, and which, when energized, produces an air stream, having a volume, and which is delivered to the passageway, and wherein the catalytic heater is mounted on the heating enclosure;

a fuel delivery conduit coupled in fluid flowing relation relative to the source of fuel and with the passageway, the fuel delivery conduit delivering the source of fuel to the passageway at a location which is downstream of the blower, and upstream of the catalytic heater;

a first remotely controllable fluid flow control device borne by the fuel delivery conduit and which is operable to selectively meter the fuel stream to the passageway; and

a second remotely controllable fluid flow control device which directs the heated fluid to the fluid dispenser and/or the fluid dispensing tank.

21. A cleaning apparatus as claimed in claim 20, and further comprising:

an air flow sensor positioned in the passageway, and which is operable to detect the volume of the air stream generated by the blower assembly;

a temperature sensor disposed downstream of the heat exchanger, and upstream of the fluid dispenser, and which is operable to detect the temperature of the cleaning fluid as the cleaning fluid departs from the heat exchanger; and

a fuel sensor disposed downstream of the catalytic heater and which is operable to detect the presence of fuel which has not been consumed by the catalytic heater.

22. A cleaning apparatus as claimed in claim 21, and further comprising:

a controller operably coupled with the pump, first and second remotely controllable fluid flow control devices; air blower assembly; air flow sensor; temperature sensor and fuel sensor, and wherein the controller causes the air blower to deliver an air stream to the passageway, and the first remotely controllable fluid flow control device to deliver the fuel stream in an amount to the passageway which results in a substantially nonflammable mixture which is delivered to the catalytic heater; and wherein the controller further causes the second remotely controllable fluid flow control device to direct the heated fluid to either of the fluid dispenser or the fluid dispensing tank.

23. A cleaning apparatus as claimed in claim 22, and wherein the controller does not permit the first remotely controllable fluid flow control device to deliver the fuel stream to the passageway until the controller energizes the air blower assembly and

then detects, by way of the air flow sensor, the presence of the air stream in the passageway.

24. A cleaning apparatus as claimed in claim 23, and wherein the controller, upon sensing the presence of fuel at a location downstream of the catalytic heater, is operable to adjust the first remotely controllable valve to reduce the amount of the fuel stream delivered to the passageway.

25. A cleaning apparatus, comprising:

a wheeled chassis which is operable to be moved across a supporting surface;

a fluid dispensing tank borne by the chassis and which dispenses a cleaning fluid which is to be applied to an object of interest;

a fluid recovery tank borne by the chassis and which receives cleaning fluid which is removed from the object of interest;

a fluid dispenser coupled in selective fluid flowing relation relative to the fluid dispensing tank and which dispenses the cleaning fluid onto the object of interest;

a fluid extractor coupled in fluid flowing relation relative to the fluid recovery tank and which removes the fluid dispensed by the fluid dispenser onto the object of interest;

a heat exchanger disposed downstream of the fluid dispensing tank, and upstream of the fluid dispenser, and which is operable to transmit heat energy to the cleaning fluid which travels from the fluid dispensing tank to the fluid dispenser;

a source of a fuel borne by the wheeled chassis and which provides a fuel stream;

an air stream mixed with the fuel stream provided by the source of fuel to produce a substantially nonflammable mixture of the fuel and air;

a catalytic heater borne by the chassis and disposed in fluid receiving relation relative to the substantially nonflammable mixture of the fuel and air, and wherein the catalytic heater, when supplied with the substantially nonflammable mixture of the fuel and air produces heat energy which is supplied to the heat exchanger for heating the cleaning fluid, and wherein the combustion produces substantially no toxic emissions;

a temperature sensor disposed downstream of the heat exchanger for detecting the temperature of the cleaning fluid which has been heated by the heat exchanger;

a first remotely controllable fluid flow control device for selectively metering the fuel stream which is combined with the air stream to produce the substantially nonflammable mixture of the fuel and air, and which is catalytically combusted by the catalytic heater;

a second remotely controllable fluid flow control device for directing the heated cleaning fluid to the fluid dispenser, or the fluid dispensing tank;

a fuel sensor disposed downstream of the catalytic heater, and which is operable to detect any fuel which passes through the catalytic heater; and

a controller borne by the chassis and which is electrically coupled in sensing relation relative to the temperature sensor, and the fuel sensor, and which further is disposed in controlling relation relative to the first and second remotely controllable fluid flow control devices.

26. A cleaning apparatus as claimed in claim 25, and wherein the second remotely controllable fluid flow control device is rendered operable by the controller to

direct the heated cleaning fluid to the fluid dispensing tank to increase the temperature of the cleaning fluid enclosed within the fluid dispensing tank.

27. A cleaning apparatus as claimed in claim 26, and wherein the second remotely controllable fluid flow control device is rendered operable by the controller to direct a first portion of the heated cleaning fluid to the fluid dispenser, and a second portion of the heated cleaning fluid to the fluid dispensing tank.

28. A cleaning apparatus as claimed in claim 26, and wherein the controller reduces the amount of heat energy produced by the catalytic heater as the temperature of the cleaning fluid increases.